Achieving Community Objectives Through Infrastructure Design

Context Sensitive Solutions Workshop
Session 4
John (Jack) Broz, P.E. HR Green
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Session 4 Objectives

• Safety
• Values change as the context changes
  – Technical
  – Regulatory
  – Community
• Community Based Design Approach
How Safe is Safe?

• Intersections, 2-Lane Highways?
• Guardrail example:
Contributing Factors to MV Crashes

- Roadway Factors: 34%
  - 3%
  - 3%
- Vehicle Factors: 12%
  - 2%
  - 6%
- Driver Factors: 93%
  - 27%
  - 57%

Source: Treat, 1980
Notion: “Better roads” can cure highway fatalities

Source: Minnesota Comprehensive Highway Safety Plan
Comprehensive Safety

Safety

– Vehicle Design
  • Preventing Crashes
  • Reducing Injuries
– Human Behavior
– Roadway Design
1972 Rear-facing child seat and child-proof door locks

1972 Volvo Experimental Safety Car (VESC)

1973 Energy-absorbing steering column

1974 Energy-absorbing bumpers

1974 Gas tank relocated for enhanced safety

1978 Child booster cushion for children

1982 Under-run protection

1982 Door mirrors of wide-angle type

1984 ABS, anti-locking brakes

1986 Brake lights at eye level

1986 Energy-absorbing bumpers

1986 Three-point seat belt in the middle of the rear seat

1987 Seat belt pre-tensioner

1987 Driver’s airbag

1990 Integrated booster cushion for children

1991 SIPS, side impact collision protection

1991 Automatic height adjustment of front seat belts

1993 Three-point inertia-reel seat belt in all the seats

1994 SIPS, side-impact airbags

1997 ROPS, Roll-Over Protection System convertible (C70)

1998 WHIPS, protection against whiplash injuries

1998 IC, inflatable curtain

1998 DSTC, Dynamic Stability and Traction Control

2000 Volvo Cars Safety Centre inaugurated in Göteborg

2000 ISOFIX attachments for child seats

2000 Two-stage airbag

2000 Volvo On Call safety system

2000 Volvo Cars Safety Centre new crash laboratory inaugurated

2001 Volvo Safety Concept Car (SCC)

2002 RSC, Roll Stability Control
Comprehensive Safety

- Towards Zero Death Initiative’s 4E’s
  - Engineering
  - Education
  - Enforcement
  - Emergency Medical Services
Defining Safety for Road Design

NOMINAL SAFETY
examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures

SUBSTANTIVE SAFETY
actual or expected crash frequency and severity for a highway or roadway segment or intersection
The concept of nominal safety is considering whether a design element meets minimum criteria.

- It is a simple “Yes/No” assessment.
Substantive Safety

• **Actual Safety Performance**
  – **Crash frequency** (number of crashes per mile or location over a specified time period).
  – **Crash type** (run-off-road, intersection, pedestrian, etc.).
  – **Crash severity** (fatality, injury, property damage).
FIGURE 1
Comparison of nominal and substantive concepts of safety. A primary goal of design exception mitigation is to increase substantive safety. (Source: NCHRP Report 480, Transportation Research Board, 2002)
Characterize the Risk

- What variables influence the risk?
  - Exposure
    - Traffic Volume
    - Location
    - Duration
  - Extent
    - Degree of variance from nominal
  - Severity
    - Define worst-case scenario outcome
What is Risk Management for Geometric Design?

Risk management in geometric design involves applying engineering knowledge and judgment to evaluate design trade-offs and incorporate performance prediction tools and technologies to enable the balancing of competing project interests including but not limited to cost, operational efficiency, environmental issues, social concerns, and specific safety measures.

*RISK MANAGEMENT = DESIGN CONSIDERATIONS*
Risk Management in Transportation

Risk comes in many forms and is inherent in the delivery and operation of transportation projects. Examples of where risk is incurred:

- Project cost (cost escalation, changes to project scope)
- Level of engineering analysis (greater investigation generally means fewer unknowns)
- Serviceability (when projects fail to satisfy performance demands)
- Legal claims and tort liability
- Safety (geometric design, structure design, geotechnical design)

Risk Basis for Improving Design

- In many cases, the risks associated with decisions can be mitigated with inclusion or enhancement of other features, which may offset the risk.

- The evaluation of risk is an interdisciplinary process requiring involvement of project team members and stakeholders based on the specific issues and an evaluation of risk tolerability.
Assessing the Risks

- Risk assessment is the process of assessing the **probability** and **severity** of adverse consequences associated with activities, recommendations or designs.

- For most transportation projects the risk assessment is not a complicated quantitative assessment, but rather a **practical assessment based on experience, engineering judgment and historical standard of practice**.

- To the extent possible, **risks should be quantified**, both on the basis of their potential probability and for their potential consequences.
Additional Safety Resources

- Mitigation Strategies for Design Exceptions (FHWA Publication)
- Interactive Highway Safety Design Model (IHSDM) http://www.ihsdm.org
Additional Safety Resources

• A Guide for Achieving Flexibility in Highway Design (AASHTO Publication)

• Mn/DOT Office of Traffic, Safety and Operations
  http://www.dot.state.mn.us/trafficeng/safety

• NCHRP Report 500-Series Safety Guides
  http://safety.transportation.org/plan.aspx
Values

• From SDIC Training
Values and the Problem Statement

Existing concerns with the stakeholders, regardless of your project!

Concerns with the stakeholders because of your project!
Detroit Lakes - Access Management

- 70 Trains/day
- Water Quality
- Economic Stability
- N-S Crossing of TH 10 & RR
- Old Hwy 10
Community Based Design

- Historical Perspective
- Community Based Design
- Return on Investment
- Network Solutions
- Functional Classification vs. Context
- Speed, Mobility and Access
- Target Operating Speed
- Flexibility in Development of Alternatives
Balancing technical marbles and vehicles.
Balancing technical and environmental marbles and vehicles.
Historical Perspective

Balancing technical and environmental and social "marbles" and vehicles.
Historical Perspective

Balancing technical and environmental and social marbles and vehicle, transit, pedestrian, cycling, freight rail, shipping, aviation modes!
Most Standards were developed "back then"
Historical Perspective

Today’s need to balance is limited by current standards.
Future Standards?

New standards are being considered to allow greater flexibility.
Real Project Scenario

New standards are being considered to allow greater flexibility.

To address real world situations.
Comprehensive “Real” Problem Statement

Public Inputs and Agency Coordination in a collaborative environment with an interdisciplinary team.

A solution that addresses real problems and is supported.
Engaged Public: 2-Lane Alternative
Frustrated Public

Can form groups such as:

Citizens Requesting Action on Pinebrook Trail- Organizational Network
(CRAPT-ON)
Return on Investment

- Missouri: We were building “spots of perfection” and fatalities were increasing.

- Kentucky: “Practical Solutions” are intended to deliver the highest rate of return for the investment.
Return on Investment: MoDOT

The Dangers of Rigid Standards

the way things were
## Return On Investment: Kentucky

### Road Improvement Example

Available budget: $500 m to improve 2 lane roads

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Crashes per Year</th>
<th>Cost (millions)</th>
<th>Speed (mph)</th>
<th>Miles</th>
<th>Total Reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Lane, 10 ft/2 ft</td>
<td>5.4</td>
<td>--</td>
<td>41.4</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2 Lane, 12 ft/8 ft</td>
<td>2.9</td>
<td>$7.2</td>
<td>46.7</td>
<td>69.4</td>
<td>173.5</td>
</tr>
<tr>
<td>4 Lane, 12 ft/8 ft</td>
<td>2.4</td>
<td>$21.5</td>
<td>55.9</td>
<td>23.3</td>
<td>69.9</td>
</tr>
</tbody>
</table>

More miles, fewer crashes and fewer delays for same budget!
Summary

- More projects with same funds
  - Decreased traffic delays
  - Improved safety
- Potential for setting system-wide approach and priorities
- Appropriate and contextual design
Network Solutions

- Gaps/connection
- Capacity of network/ spot improvements
- Intersections: signal network/ interconnection
- Inter-jurisdictional
Functional Classification does not change when context changes.
Result: Identical design criteria applied to different contexts
Figure 5.1 Roads in Context

The photos enclosed in a yellow box indicate the Town Center and Core City streets that also operate as a local or regional Main Street.
### Table 6.2 Matrix of Design Values

<table>
<thead>
<tr>
<th>Regional Arterial</th>
<th>Rural</th>
<th>Suburban Neighborhood</th>
<th>Suburban Corridor</th>
<th>Suburban Center</th>
<th>Town/Village</th>
<th>Town/Village Center</th>
<th>Urban Core</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lane Width</strong></td>
<td>11' to 12'</td>
<td>11' to 12' (14' to 15' outside lane if no shoulder or bike lane)</td>
<td>11' to 12'</td>
<td>11' (14' outside lane if no shoulder or bike lane)</td>
<td>10' to 12' (14' outside lane if no shoulder or bike lane)</td>
<td>10' to 12' (14' outside lane if no shoulder or bike lane)</td>
<td>10' to 12'</td>
</tr>
<tr>
<td><strong>Paved Shoulder Width</strong></td>
<td>8' to 10'</td>
<td>8' to 10'</td>
<td>8' to 12'</td>
<td>4' to 6' (if no parking or bike lane)</td>
<td>4' to 6' (if no parking or bike lane)</td>
<td>4' to 6' (if no parking or bike lane)</td>
<td>4' to 6' (if no parking or bike lane)</td>
</tr>
<tr>
<td><strong>Parking Lane</strong></td>
<td>NA</td>
<td>NA</td>
<td>8' parallel</td>
<td>8' parallel; see 7.2 for angled</td>
<td>8' parallel; see 7.2 for angled</td>
<td>8' parallel</td>
<td>8' parallel</td>
</tr>
<tr>
<td><strong>Bike Lane</strong></td>
<td>NA</td>
<td>(if no shoulder)</td>
<td>5' to 6'</td>
<td>5' to 6'</td>
<td>5' to 6'</td>
<td>5' to 6'</td>
<td>5' to 6'</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>4' to 6'</td>
<td>6' to 8' for pedestrians only</td>
<td>6' to 8' for pedestrians only</td>
<td>16' to 18' for LT, 6' to 8' for pedestrians only</td>
<td>16' to 18' for LT, 6' to 8' for pedestrians only</td>
<td>16' to 18' for LT, 6' to 8' for pedestrians only</td>
<td>16' to 18' for LT, 6' to 8' for pedestrians only</td>
</tr>
<tr>
<td><strong>Curb Return</strong></td>
<td>30' to 50'</td>
<td>25' to 35'</td>
<td>25' to 50'</td>
<td>15' to 40'</td>
<td>15' to 40'</td>
<td>15' to 40'</td>
<td>15' to 40'</td>
</tr>
<tr>
<td><strong>Travel Lanes</strong></td>
<td>2 to 6</td>
<td>2 to 6</td>
<td>4 to 6</td>
<td>2 to 4</td>
<td>2 to 4</td>
<td>2 to 4</td>
<td>2 to 6</td>
</tr>
<tr>
<td><strong>Clear Sidewalk Width</strong></td>
<td>NA</td>
<td>5'</td>
<td>5' to 6'</td>
<td>6' to 8'</td>
<td>6' to 10'</td>
<td>4' to 6'</td>
<td>5' to 10'</td>
</tr>
<tr>
<td><strong>Buffer</strong></td>
<td>NA</td>
<td>6'+</td>
<td>6' to 10'</td>
<td>4' to 6'</td>
<td>4' to 6'</td>
<td>4' to 6'</td>
<td>4' to 6'</td>
</tr>
<tr>
<td><strong>Shy Distance</strong></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0' to 2'</td>
<td>0' to 2'</td>
<td>2'</td>
<td>2'</td>
</tr>
<tr>
<td><strong>Total Sidewalk Width</strong></td>
<td>NA</td>
<td>5'</td>
<td>5' to 6'</td>
<td>9' to 14'</td>
<td>10' to 16'</td>
<td>12' to 18'</td>
<td>12' to 20'</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>Desired Operating Speed</td>
<td>45-55</td>
<td>35-40</td>
<td>35-55</td>
<td>30-35</td>
<td>30-35</td>
<td>30-35</td>
</tr>
</tbody>
</table>

1. 12' preferred for regular transit routes, and heavy truck volumes > 5%, particularly for speeds of 35 mph or greater.
2. Shoulders should only be installed in urban contexts as a retrofit of wide travel lanes to accommodate bicyclists.
3. Buffer is assumed to be planted area (grass, shrubs and/or trees) for suburban neighborhood and corridor contexts; street furniture/car door zone for other land use contexts. Min. of 6' for transit zones.
4. Curb return radius should be as small as possible. Number of lanes, on street parking, bike lanes, and shoulders should be utilized to determine effective radius.
Speed, Mobility and Access

• Design Speed Decision profound impact on all design decisions

• Mobility is more important than speed

• Effective Access is critical to local concerns/values

• Roadway design needs to balance context’s demands
### Target Operating Speed

<table>
<thead>
<tr>
<th>Design Speed</th>
<th>Posted Speed</th>
<th>Operating Speed</th>
<th>Target Speed</th>
</tr>
</thead>
</table>

**Target Speed** is the speed at which vehicles *should operate* on a thoroughfare in a specific context, consistent with the *level of multimodal activity* generated by *adjacent land uses* to provide for the mobility for motor vehicles and *safe* environment for pedestrians and bicyclists.
Figure 6. 85th percentile speed versus posted speed for NCHRP, Texas, and FHWA data.

Source: NCHRP Report 504
### Suburban/Urban Speeds

**Table 24** Percentile speed that equals posted speed by area type and posted speed

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Speed Limit (mph)</th>
<th>Percentile at or below Given Speed*</th>
<th>Number of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speed Limit</td>
<td>Speed Limit Plus 5 mph</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Speed Limit Plus 10 mph</td>
<td></td>
</tr>
<tr>
<td>Suburban/Urban</td>
<td>25</td>
<td>42</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>28</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>32</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>37</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>43</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>48</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: NCHRP Report 504

How do you select Design Speed?
Vehicle Speeds and Pedestrians

UK: Department of Environment, Transport, and the Regions, (DETR)

Florida, 1993-1996; pedestrians in single-vehicle crashes
Community Based Design Process

1. Understand Context
2. Problem Statement
3. Alternative Development
4. All Users’ “LOS”
5. Design Flexibility
How do I document?

- Mn/DOT’s Roundabout Documentation has good examples
  - Formalized Design Report- documenting design decisions
  - Knowledge Transfer from Mn/DOT Roundabouts
Session 4 Objectives

- Safety
  - Perform a **Substantive Safety** analysis
  - Consider all modes
  - Assess and manage project risks
Session 4 Objectives

Values change as the context changes

– Technical
– Regulatory
– Community
Session 4 Objectives

• Community Based Design Approach
  – Consider a “Community First’ approach to building a problem statement
  – Get input and feedback from the stakeholders on regulatory and community issues
  – Don’t “fall in love” with your design